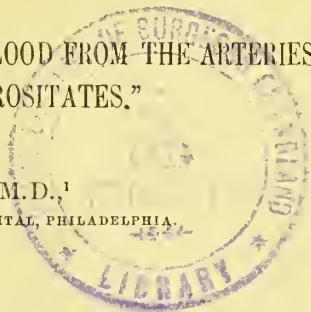


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HARVEY AND THE TRANSIT OF THE BLOOD FROM THE ARTERIES TO THE VEINS "PER POROSITATES."

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IN the life of Harvey, written by Doctor Robert Willis, and prefixed to his translation of the works of Harvey, page xli., published by the Sydenham Society, in 1847, we find this assertion: "For Harvey, it must be observed, left the doctrine of the circulation as an inference or induction only, not as a sensible demonstration." Again: "His [Harvey's] idea of the way in which it was accomplished [transit of the blood from the arteries to the veins] was even defective; he had no notion of one order of sanguiferous vessels ending by uninterrupted continuity, or by an intermediate vascular network, in the other order."

In Sharpey and Quain's Anatomy (see "capillaries"), we find the following statement: "That the blood passed from the arteries into the veins was of course a necessary part of the doctrine of the circulation, as demonstrated by Harvey; but the mode in which the passage took place was not ascertained until some time after the date of his great discovery." The words "not ascertained" in this paragraph are guarded, yet the impression is decidedly made that Harvey did not have the idea of the way in which the blood is conveyed from the arteries to the veins. The same statement has been made by others.

In a lecture delivered at the Royal Institution, London, on the 25th of January last, Mr. Huxley is reported as having said: "One thing Harvey could not do, because the instruments of the time would not enable him to do it. He never gave the exact channels by which the blood passes into the veins."—*British Medical Journal*, Feb. 2, 1878.

Harvey's treatise, written in Latin, was published first at Frankfort, in 1628. It is a fact that the compound microscope, consisting of two lenses placed at a distance, so that the one next the eye magnifies the enlarged image of any object placed in front of the other, was invented by Hans Zansz, who, with his son, Zacharias Zansz, were spectacle makers at Mid-

¹ An extract from an address delivered before the College of Physicians of Philadelphia, on the Tercentennial Anniversary of Harvey's birth, April, 1878.

dleburg, in Holland, about the year 1590. One of their microscopes, which they presented to Prince Maurice, was, in the year 1617, in the possession of Alkmaar, who then resided in London as mathematician to King James VI. (See Quckett *On the Microscope*, who speaks on the authority of Sir David Brewster; see also *Encyclopædia Britannica*, "Microscope.")

It does not require, however, a compound microscope to see the vessels in question. A common double convex spectacle glass, magnifying only three and a half diameters, gives a clear view of "the capillary vessels." With such a glass I have seen them in the cat. Now Harvey saw and described the "punctum saliens" of the egg, with what he calls "perspicilli." (*Harveii Opera*, Royal College of Physicians' edition, 1766, page 249.) And on page 255 he says: "Clariori tamen luce, perspicillis que adhibitis," etc. And again, page 267: "Apparuit (perspicillis utenti) in cervice, venæ ad cerebrum ascendentes quasi punctum sanguineum."

Harvey was in the habit of using a double convex lens. He describes one of manifestly greater power than those used in common spectacles; for, on page 338, *Harveii Opera*, he says: "Quippe radiis solaribus per exiguum vitrum transmissis, et in conum unitis, igne conestim excitato."

According to Boerhaave, Swammerdam had recognized the blood corpuscle in 1658. (See Tyson *On the Cell Doctrine*, page 16.) He must have used a very far higher power than enables one to see the capillary vessels. Now Harvey died in 1657.

The opinion held and expressed by the above-mentioned writers is, perhaps, ~~predicated~~ on that which we find in the life of Harvey, written by Doctors Lawrence and Akenside, and published together with his works, under the auspices and by the authority of the Royal College of Physicians of London, in 1766. This work, received everywhere now as authority in matters concerning Harvey, has these words on page xiii., *Harveii Vita*:—

"Duo sunt quidem, ut nequid dissimulemus, quibus in ratione sanguis circumferendi explicanda Harveium defecisse dolemus. . . . Arteriarum etiam minutarum cum venis conjunctionem primum pernegavit; eandem postea invitatus agnovisse videtur, nec tamen rem penitus intellexisse." And on page xxix, "Concedit arteriarum propagines minimas inter venarum tunicas ita posse perrepere, ut sanguis in venas obliqua tradatur via, quali scilicet ureteres in vesicam, et ductus choledochus in intestinum progrediuntur."

I take leave to state, with the greatest diffidence, that a contrary opinion is forced upon me, after an extended examination of Harvey's works. I take leave further to state, that, in using the word "~~porositates~~ *canalis*," found in the short fourteenth chapter of his work, *De Motu Cordis*, etc., Rotterdam editions of 1648-1654 and 1661, by Arnold Leers, and London edition of 1661, by R. Danielis; and in his second letter to Riolanus, Rotterdam edition, 1661, page 277, ~~where~~ Harvey sums up his views on the circulation, and traces the blood through the arteries into the "porositates,"

in both of which places

which he does whenever he speaks of the passage of the blood from the arteries to the veins

and especially

and through the "porositates" into the veins, and through the veins into the heart, Harvey more clearly expresses the true idea of the transit of the blood from the arteries to the veins than is now conveyed by the expression "capillary system of vessels." The word "capillary" relates only to the hair-like appearance of the vessels, while "porositates" translated into plain English would be "ferries," and relates to an *exact function*, namely, that of passing the blood in *one direction only*, that is, from the arteries to the veins. Now, these "ferries," the ferry vessels, the ferry system of vessels, under the designation of "porositates," Harvey points out and dwells upon.¹

In this fourteenth chapter Harvey writes: "Quod sanguis, per pulmones et eor, pulsu ventriculorum pertranseat, et in universum corpus impellatur et immittatur, atque in venas et porositates carnis obrepit, et per ipsas, undique de circumferentia ad centrum, ab exiguis venis in majores remeet." And so in his second letter to Riolanus, page 277, Rotterdam, 1661: "Nempe de auriculâ dextra, in ventriculum, de ventriculo per pulmones, in auriculam sinistram, inde in ventriculum sinistram et in aortam, omnesque per arterias à eorde, per partium porositates, in venas, et per venas, ad cordis basin, quam celeriter revertitur sanguis." Surely it is manifest here that Harvey places a *tertium quid* between the arteries on the one side and the veins on the other side. He calls this *tertium quid* "porositates carnis" and "partium porositates." He meant to convey the idea, and with force he does convey the idea, that the "porositates" take the blood from the arteries, and through the parts, and into the veins. The position in which Harvey places the word "porositates" and its derivation, and its being used in the plural number, all these considerations force me to believe that he used it knowingly and in preference to any other word, such as ductus or capillares, and as conveying the meaning that the blood made the transit from the arteries to the veins, and in one continuous direction, and through vessels with sides to them, and that the blood did not return through these vessels, namely, through the porositates from the veins back into the arteries; the word "capillares," or ductus, embracing no such meaning as that a return of the blood could not take place.

First, then, in regard to the places where Harvey uses it. We find he always uses it in speaking of the passage of the blood from the arteries to the veins.² Thus in chapter VII., *De motu cordis*, Rotterdam, 1648,

¹ I use the word ferry, Saxon *faran*, to pass, in its original sense, that in which Spenser uses it, "Him to ferry over that deep flood." And in Shakespeare, "The melancholy flood, with that grim ferryman, which poets write of, unto the kingdom of perpetual night" (Richard III.). In this sense the word does not comprehend a return. *2. pass'd*

² One exception to this is found in the letter to Slegel, and will be mentioned hereafter, where, by the departure, Harvey further and forcibly gives his meaning.

page 97, "*Denique clarè apparet assertio nostra, continuè et continenter sanguinè per pulmonum porositates permeare, de dextro in ventriculum sinistrum,*" etc. In chapter XI. page 126 "*(vel per anastomosin immediate, vel mediate per carnis porositates, vel utroque modo), transire ab arteriis in venas.*" In the Rotterdam edition of 1648, the two letters to Riolanus do not appear, having been written at a later period; but these letters are in all the other editions to which I have alluded. Now these letters were written by Harvey for the purpose of explaining further his views concerning the circulation, and should be taken as of equal force with the text.

In the first letter, on page 189, we find, "*Non enim tanto sanguine quantum pars quaeris in suis arteriis, venis et porositatibus ubique continet, pro alimento utitur.*" And on page 191, "*de porositatibus in venulas.*" And on page 193, "*Verum amplius, quod ipse sanguis è porositatibus partium regrediatur,*" etc. And on page 268, and in the second letter, "*ut exinde fluxus sanguinis et citatior eursus, per arterias exiles, partium porositates, venarumque omnium ramos, necessario fiat, et exinde circulatio.*"

In the second letter, page 277, we have, in the three editions I have mentioned, "*Omnesque per arterias a corde, per partium porositates, in venas, et per venas, ad cordis basin.*" In the Royal College of Physicians' edition, page 138, the comma so emphatic after porositates, and also that one after per venas, are both omitted. Manifestly by so doing a distinction, an emphasis is done away with, and that, too, in a place where Harvey was very explicit. Again in the fourteenth chapter of Harvey's text, and in the four editions I have alluded to, which are the only ones I have access to, but which in this chapter are uniform, totidem verbis et syllabis, we have "*et immittatur, atque in venas et porositates carnis obrepit, et per ipsas, undique de circumferentia ad centrum.*" In the Royal College of Physicians' edition of 1766, page 65, we find that the comma after ipsas is omitted, and that the word "*venas*" is inserted between ipsas and undique, thereby changing the meaning of Harvey. Surely these are grave errors, made by the learned editors.

To show both the onward course of the blood, as well as the continuous walls of the vessels in which it flowed, Harvey says on page 168 (Rotterdam edition, 1661), "*Adeo ut ultimae divisiones capillares arteriosae videantur venae, non solum constitutione, sed et officio.*" In plain English, "*So that the ultimate capillary divisions of the arteries appear like the veins, not merely in constitution, but also in function.*" On page 141 (Rotterdam edition 1661), "*Nam duos contrarios motus in capillari propagine, chyli sursum, sanguinis deorsum, [in]convenienter et [im]probabiliter fieri existimare necesse esset.*" In English, "*Two contrary motions in the capillary set, chyle going one way and blood in the reverse way, can not well exist.*" Harvey well knew that if "*ductus*" and "*capillares*" would permit possibly of a current in one way and then in the reverse way, "*porositates*"

would exclude such an idea. He knew that "porositates" would convey the sense its derivation entitles it to, and no other. The word has a Greek root, with a Latin termination, in the feminine gender. The root is *πορος*, the verb is *περαω*, to drive right through, to pass through, to traverse; *περαω εἰς Ἀΐδαο*, Homer says, to reach the abode of Hades. This word is never used by the ancient writers, so far as I know, as expressing or comprehending any idea of return.

Πορος the noun means a *ferry*, a passage. Thus Æschylus speaks of *πλουτωνος πορος*, the Stygian ferry. Pindar sings *Βιον πορος*, the stream of life. Pindar and Æschylus speak of *πορος Ἑλλης*, the Hellespont. Pindar says *πορος σκαμανδρον*, the Scamander. *Πορος Νειλον*, the Nile. There is no reflow, no reverse tide in these rivers; they flow towards the sea.

But the Euripus, the strait on the east of Greece, is not spoken of as *πορος Ευριπον*, for here the water flows through and then reflows at stated intervals, to which facts the ancients often allude. These old writers use the word *πορος* with ~~exactness and precision~~ in describing the continuous current of the classic rivers of antiquity; so, too, Harvey, with great taste and meaning, used it as pointing out the ever onward flow of the tide he wished to demonstrate.

Doctor Robert Willis has given the English word "pores" as the translation of Harvey's Latin word "porositates," thus for "atque in venas et porositates carnis obrepat, et per ipsas, undique de circumferentia ad centrum, ab exiguis venis in majores remeet" (see fourteenth chapter Rotterdam edition 1661), Willis has, "where it (the blood) makes its way into the veins and pores of the flesh, and then flows by the veins from the circumference on every side to the centre, from the lesser to the greater veins." (See works of Harvey, page 68, edition of Sydenham Society.) And for "omnesque per arterias corde, per partium porositates, in venas, et per venas, ad cordis basin, quam celeriter revertitur sanguis" (see second letter to Riolanus, page 277 Rotterdam edition, 1661). Willis has, "whence by the arterics at large through the pores or interstices of the tissues into the veins, and by the veins back again with great rapidity to the base of the heart." (See works of Harvey, page 138, edition of the Sydenham Society.)

It is a grave error to attribute to the word "porositates" a loose and secondary sense, such as belongs to the English word "porosity." This sense would not likely be in the mind of those who used the word when it was still comparatively a recent one, and when its derivation was still fresh in men's minds, and when the Greek authors were studied by physicians and all other scientific writers. It is an error to suppose the word bore a mere abstract meaning corresponding to its abstract form, and that it indicated no more than a mere spongy quality in the parts of the body through which the blood passed from the arteries to the veins. In Harvey's age the idioms of the best Latin writers were more or less cultivated.

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The fact, too, that nouns abstract in form were nearly as often concrete in sense as not, shows that Harvey's words were not open to this misconception. For it was well known that Cicero spoke of "magnas clientelas" when he meant "multos clientes." And that when Tacitus spoke of "familiaritates ejus" in the case of Agricola, he meant "familiares ejus." A multitude of such cases could be alleged. Especially is the plural use of the word to be observed as decidedly militating against the notion that it was used by Harvey in an abstract sense. A living tongue is kept supple by daily use; it is pliant; we find that a new tinge is often imparted to words already in use, and by assimilating foreign idioms it creates new expressions for new ideas. The dead languages, on the contrary, are fixed, having been cast into moulds by races of men long since passed away; there is no change in them.

The modern word "porosity" is alloyed—it is below the standard of *πορος*. But because, in the stream of to-day, the word is changed, shall we be taught that the distant fountain was not clear, and possessed not the virtue once attributed to it by Harvey? And used, too, as it was, by him for many reasons, as conveying the meaning the ancients gave it? Well may Coleridge tell us that "the position of science must be tried in the scales of the jeweller; not like the mixed commodities of the market, on the weighbridge of common opinion and vulgar usage."

The further assertion of Drs. Lawrence and Aikenside, namely, that Harvey believed "the blood to be delivered in an oblique way into the veins, in the way the ureters proceed into the bladder, and the common choledoch duct enters the intestine," is an error, promulgated under the sanction of the Royal College of Physicians of London (unwittingly), and consequently received and believed, and has done more to cloud the view of Harvey's teaching on this point than any other agency of which I am aware. I do not believe that such a view could be taken by one properly construing Harvey's text, and taking, singular and combined, the meaning and intent of his words. The passage from which this idea is taken by the authors of *Harveii Vita*, is found in the letter of Harvey to his friend Paul Slegel, of Hamburg, and is dated London, April, 1651.

I have seen this letter of Harvey only in the Royal College of Physicians' edition of 1766. I will give my translation of the words of Harvey as found in his letter to Slegel in this edition; beginning on page 617 at the words "Quæris autem," and ending with the words "adigere queas."

"But you will ask what on earth is this contrivance? what on earth these ducts? Certainly the little arteries,¹ which are always smaller, shall I not say twice or three times, than the veins (which they accompany, and to which they gradually approach), and at length are lost in the coats of the veins: so that I may believe that the blood borne forward by them (the little arteries) flows

¹ In using the word "arteriolæ" in this place instead of the word "porositates" as heretofore, Harvey increases the strength of his position in pointing out the continuous channels in which the blood flows in passing the periphery.

Philadelphia 15 october 1878

No 1405 Locust street

James G Wakeley M.D. - M.R.C.S

423 Strand W.C

London

Dear Sir

I beg to enclose herewith
an extract from an address I delivered
before the College of Physicians of Philad^a
Doctor Hays published this extract in
the American Journal Med Sciences for
July - Should you read it I hope you
may be able to come to my way of
thinking on the subject of Harveys "Fores
Vessels", the translation I have ventured
to give his word "porositates". Should
this be the case I hope you will give my
extract a place in your Journal.

I beg you will not think me
impertinent in asking this. Let me

hope it will indicate to our British friends that we have kindred associations, mutual interests and literary tastes and that we are not indifferent to a noble ancestry. I believe the criticism I have ventured to make is entirely new. I have had the satisfaction of receiving from the Professor of Anatomy Physiology and Surgery in the University of Virginia and from friends at other seats of learning, congratulations as having sustained the view I have advanced.

Fearing this note may not reach you on account of postal derangement I have asked my friend the Hon^{ble} John Welsh our Minister at the Court of Saint James to be good enough to have it sent to your office.

Should you be good enough to
publish ~~it~~ ^{the extract} I beg you will send
a copy of the Lancet in which it
may appear to Mr Welsh.

I beg you will consider this
little note as entirely private.

Very Respectfully
yours Obit Scot
Jas Forbes

James & Watson & Co. ^{London}

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slowly between the coats of the veins; and the same happens here, which becomes usual at the junction of the ureters with the bladder, and the biliary pores with the intestine. For the ureters are insinuated into the bladder obliquely and tortuously, and not in the nature of an anastomosis: affording now and then a way for calculi and pus and blood; so that by them you can easily fill the bladder with air or water; but by no effort can anything be driven from the bladder back into the ureter."

Now what does Harvey mean when he says "the same happens here which becomes usual at the junction of the ureters with the bladder?" What is it that happens there? Harvey goes on to say that it is the prevention of the return of water from the bladder to the ureters. To place any other construction or sense on this sentence is to do violence to Harvey's meaning; the whole context shows this. ~~For it had been~~ asserted by Riolanus and others that there was an anastomosis by conjunction, and that there was a reflow of the blood from the veins to the arteries after the manner of Euripus. Slegel calls Harvey's attention to these statements of Riolanus (see Harvey's letter to Slegel). Hence Harvey's reply to Slegel, in which he explains his (Harvey's) anastomosis, which he goes on to say is not by conjunction, "per copulam," but takes place by means of "arteriolæ." These are the vessels he had in his publications hitherto called "porositates," thus pointing out that in vessels with continuous coats, that ~~is~~ walled vessels, the blood progressed, journeyed to the veins. Then, he explains that there were other places in the body where there was no anastomosis, yet where water, pus, calculi, etc., could pass in one way, but by no effort could anything be forced back again; that this happened where the ureters enter the bladder, and where the common choledoch duct enters the intestine. Further on he repeats this simile, and refers to his letter to Riolanus. In chapter xiii. of his text Harvey had demonstrated that the valves in the veins prevented any return of the blood.

To sum up, then, from the testimony, we are forced to the belief that Harvey did have the means of seeing, and that he did know, and was the first to point out, that "order of sanguiferous vessels ending by uninterrupted continuity" in the arteries at one extremity, and in the veins at the other extremity; and that under the title of "porositates" he gave "the exact channels," *the ferry system of vessels* by which the blood passes from the arteries into the veins. This belongs to Harvey, and to Harvey alone.¹

From this view, then, of Harvey's writings, I ask the question, and I hope at some future time it will be answered, have not these great authorities—Willis, Huxley, and the Royal College of Physicians of London—done their illustrious countryman, Harvey, great injustice? For "have they been sufficiently circumspect? Have they sufficiently inquired into Harvey's meaning? Have they quoted his words faithfully?" If they

¹ Malpighi afterwards further elaborated the same subject. Malpighi, *Opera*. London, 1686.

have not, in what does their position before the world differ from that of Doctor Geynes (see Dr. Sieveking's Harveian oration, *Lancet*, vol. i., 1862), who, according to Doctor Munk, in his role of the College of Physicians, was brought by the Fellows to the bar of the College for venturing to question the authority of Galen, and made to recant or go to prison?

Let us indulge the hope that these gentlemen, like Dr. Geynes, will recant. Let us believe that the Royal College of Physicians of London, the special beneficiary of Harvey's trust, will not sanction the keeping of Harvey's name in a relation so false as that in which it has been placed in regard to the transit of the blood from the arteries to the veins. Let us hope the College will give the world a new and revised edition of his life and works, and, as this coin bears the image and superscription of the King, "Render unto Cæsar the things that are Cæsar's."

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